NAVAL AIR DEVELOPMENT CENTER

WARMINSTER, PA. 18974

REPORT NO. NADC-73019-30 17 JAN 1973

LIQUID OXYGEN SAMPLER EVALUATION

PHASE REPORT

AIRTASK A510 5103/0014/3510000002
Work Unit A5311B-40

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DEPARTMENT OF THE NAVY
NAVAL AIR DEVELOPMENT CENTER
WARMINSTER, PA. 18974

AIR VEHICLE TECHNOLOGY DEPARTMENT

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A comparative analysis of the Navy's G-276 Liquid Oxygen Sampler and a modified sampler origiaally designed by the Naval Air Test Center, Patuxent River, Maryland was made. Evaluation of the samplers was made on the basis of efficiency, reliability, convenience, safety and cost.

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INTRODUCTION

Effective quality control over liquid oxygen supplies from manufacturer to final storage facility requires efficient sampling procedures and accurate analysis. Samples must be obtained which are free from external contamination and must be transported to test facilities in leak-proof containers. Deficiencies in the Navy sampling equipment has promoted work on a new type of sampling system initiated by the Naval Air Test Center, Patuxent River, Maryland. Modifications of this unit have been made by the Naval Air Development Center and a comparative study was made of the two techniques with respect to sampler efficiency, convenience, reliability, cost and safety.

DESCRIPTION

The sampler presented in this report is a modification of a sampler designed by the Naval Air Test Center, Patuxent River, Maryland. The original design of this sampler is shown in Fig. 1.

The description and component parts of the G276 sampler (Figures 2 and 3) can be found in Report No. NADC-MA-6976. The description, operation and component parts of the modified Patuxent River sampler are contained in the following pages.

This modified unit consists of two sections (Fig. 4): the actual sampling unit and a collecting cylinder (FSNRM8120-255-2799) which is the same cylinder used in the G276 sampling system. The actual sampling unit (Fig. 5) is comprised of: an inlet to the manifold with a ball valve to control the flow of LOX (liquid oxygen) to the sampler; a small cylinder (bailout bottle) where the sample of LOX is stored during the sampling time; an overflow line with ball valve which permits the LOX to escape when the small cylinder is full; a pressure relief valve which makes the unit safe from over-pressurization during sampling; a pressure gauge to indicate the amount of sample collected; and an outlet with a ball valve to permit the gaseous oxygen to flow into the large sample cylinder.

OPERATION

The actual operation of this unit is relatively simple. The unit is attached to the liquid oxygen source by the use of stainless steel flexible tubing while the sample cylinder is attached to the other end of the unit (Fig. 4, 6 and 7). When this hook-up is complete, valves 1, 2 and 3 (Fig. 5) and the sample cylinder containing residual oxygen from previous tests are opened and this residual oxygen is allowed to flush out the entire system. When this step has been completed, valve 3 is closed and liquid oxygen from the source is allowed to flow into the sampling unit. This flow is continued until the small steel cylinder is full as indicated by a steady stream of LOX flowing from the overflow outlet. When such a state has been attained,

valves 1 and 2 are closed while at the same time the LOX source is shut-off. Valve 3 is then opened which permits the gaseous oxygen to flow into the sample cylinder during the LOX warm-up period. This warm-up period is completed when no more pressure increase is observed. When this state is reached the sample cylinder is closed and the sample unit is disconnected from both the LOX source and sample cylinder. Due to the fact that this sampling unit can be disconnected from the sample cylinder, only one sampling unit is needed per LOX installation. Moreover, only the cylinder has to be shipped to the place of analysis.

DISCUSSION AND EVALUATION

Samples of oxygen using both the G276 and this new sampler were taken. Analysis was then made with respect to contamination using infrared spectrophotometry to compare the two methods of sampling. These data are presented in Table I as well as the IR spectrums in Figures 8 through 12. They show that this new method of sampling eliminates some contamination that is obtained using the G276 sampler. The methane (CH_4), carbon dioxide (CO_2) and water vapor (H_2O) were almost always lower in concentration using this new sampling unit. The reason for this is basically two-fold. First, the G276 sampler is an open system while the new sampler is a closed system. An open system allows contamination from the atmosphere, while a closed system does not. Secondly, with the G276 sampler the contaminants are concentrated due to some initial boil-off of the LOX.

While it can be seen from the infrared spectra, (Figures 8 through 12) and the data presented in Table I, that the difference in contaminant concentration between the samples of LOX using the two samplers was significant, it could not be considered extreme. This relatively narrow spread between the LOX samples is attributed to the fact that the sampling operation was performed by experienced personnel who were able to permit minimum exposure to the atmosphere and boil-off time.

One benefit of this new sampler is the cost. As stated previously only one unit is needed per LOX facility. The unit has a cost of approximately $120. Furthermore, the oxygen sample cylinder would represent no additional cost because the Navy is presently using this for the G276 sampler.

The only problem encountered with this new sampling unit is that it is time consuming. The cool-down and warm-up times shown in Table I are quite long due to the mass of the unit. However, when time is not critical, this unit offers definite advantages.

CONCLUSIONS

It is concluded that the modified Naval Air Test Center sampling unit can be used to obtain better results from routine sampling of LOX supplies from storage facilities, cart, and truck deliveries than those obtained with the G276.

FUTURE PLANS

It is planned that further work be done on this sampler in the following areas:

1. More extensive tests should be performed on oxygen supplies whose quality is questionable.

2. Further design work should also be initiated to eliminate the long cool-down and warm-up times.

TABLE I

RESULTS OF ANALYSIS

Figure Number	Type of Sampling System	Relative Humidity when sample was taken	Temperature when sample was taken	System Cool-down Time Min./Sec.	System Warm-up Time	Total Pressure of sample Achieved (psig)	PPM of CO_2 Present	PPM of CH_4 Present
8	G276	71	80	3/50	---	190	1.1	23
8	NADC modified sampler	71	80	6/15	17 min.	400	1.1	25
9	G276	72	81	3/30	---	260	1.7	27
9	NADC	72	81	4/15	24 min.	550	1.3	20
10	G-276	78	69	3/48	---	120	2.0	29
10	NADC	78	69	6 min.	22 min.	400	1.1	29
11	G-276	50	84	1/30	---	245	1.5	20.5
11	NADC	50	84	4 min.	18 min.	450	1.2	28
12	G-276	78	69	3/50	---	306	1.5	36
12	NADC	78	69	5/50	26 min.	125	1.1	26

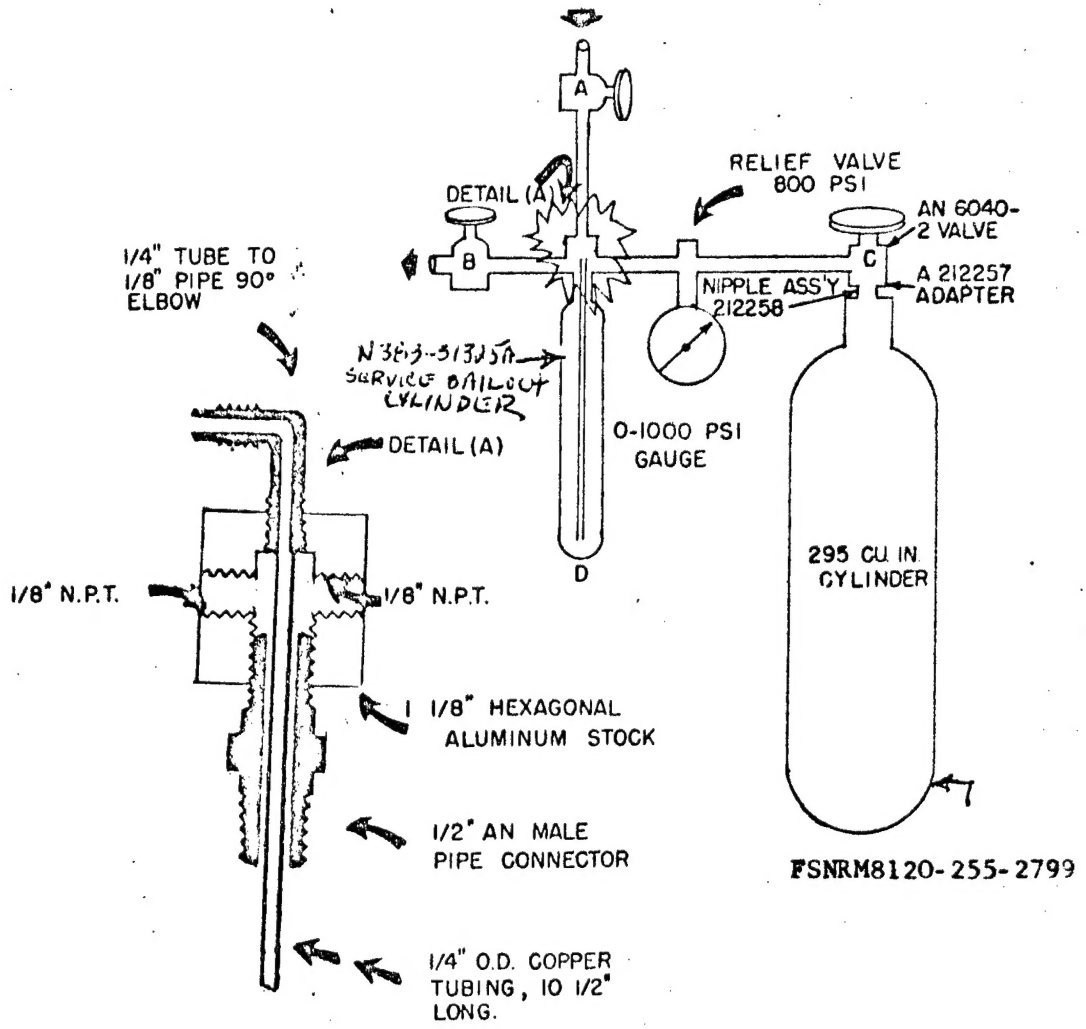


Figure 1. SCHEMATIC SHOWING DETAILS OF FABRICATION OF PAX AM SAMPLER

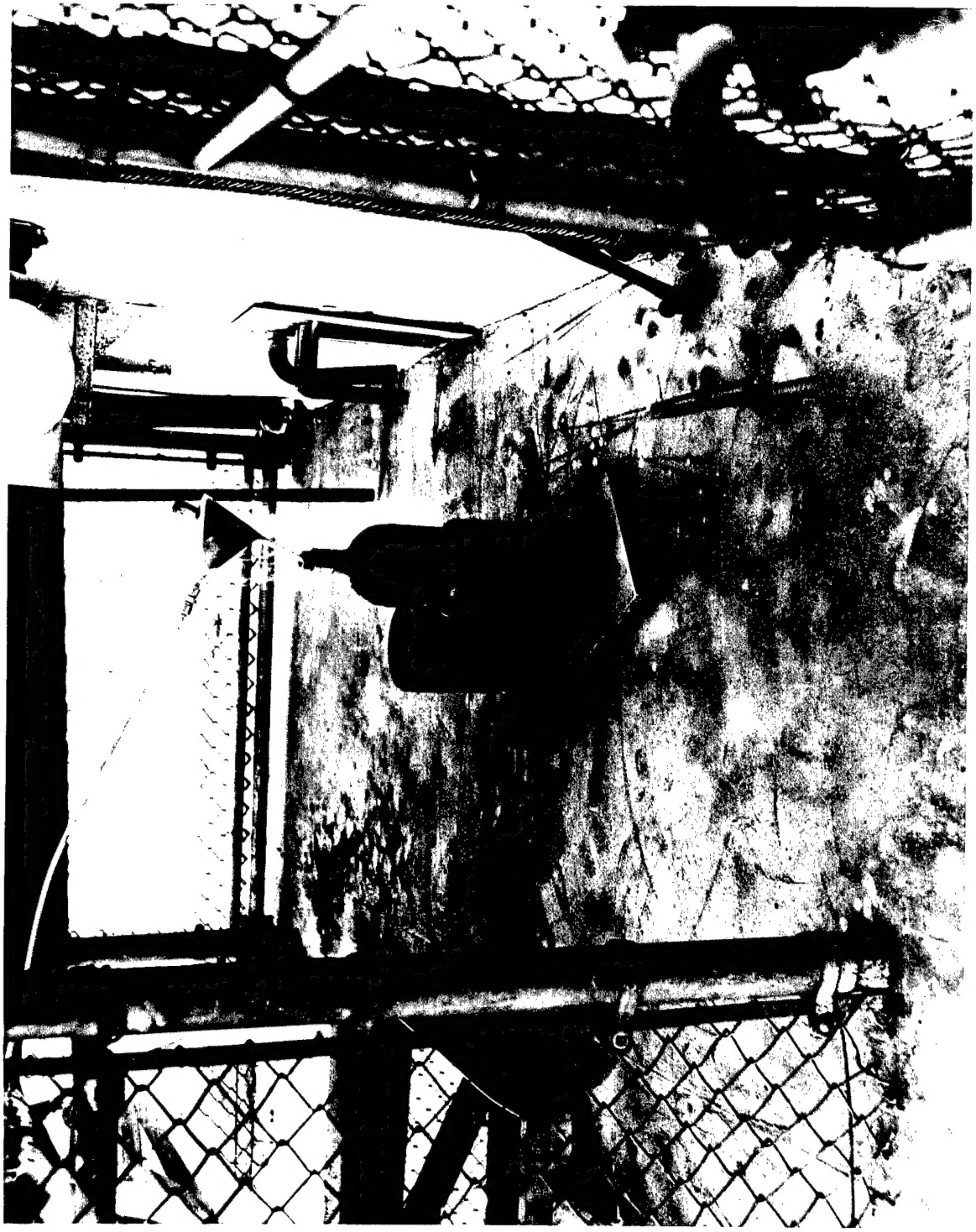


Figure 2. G276 SAMPLER - COOLING STAGE

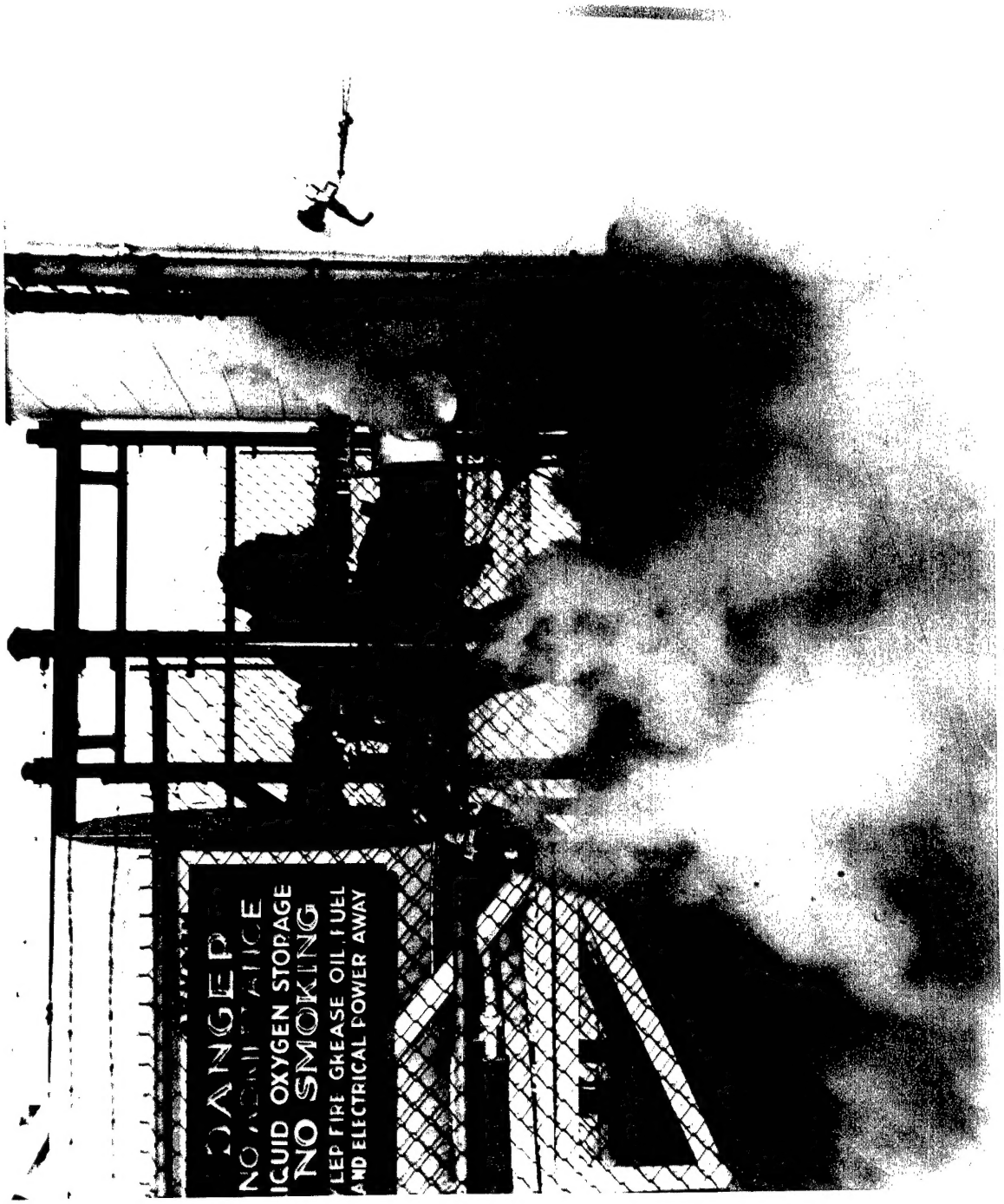


Figure 3. G276 SAMPLER - SAMPLING STAGE

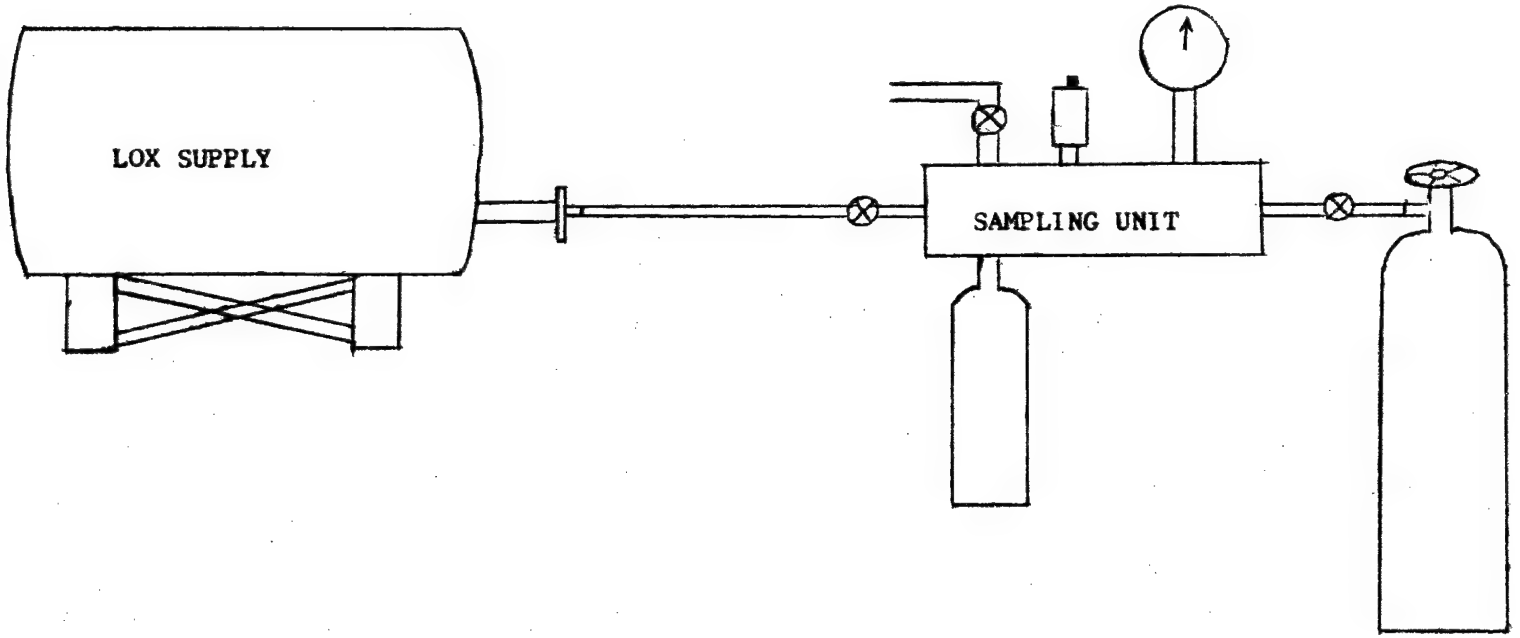
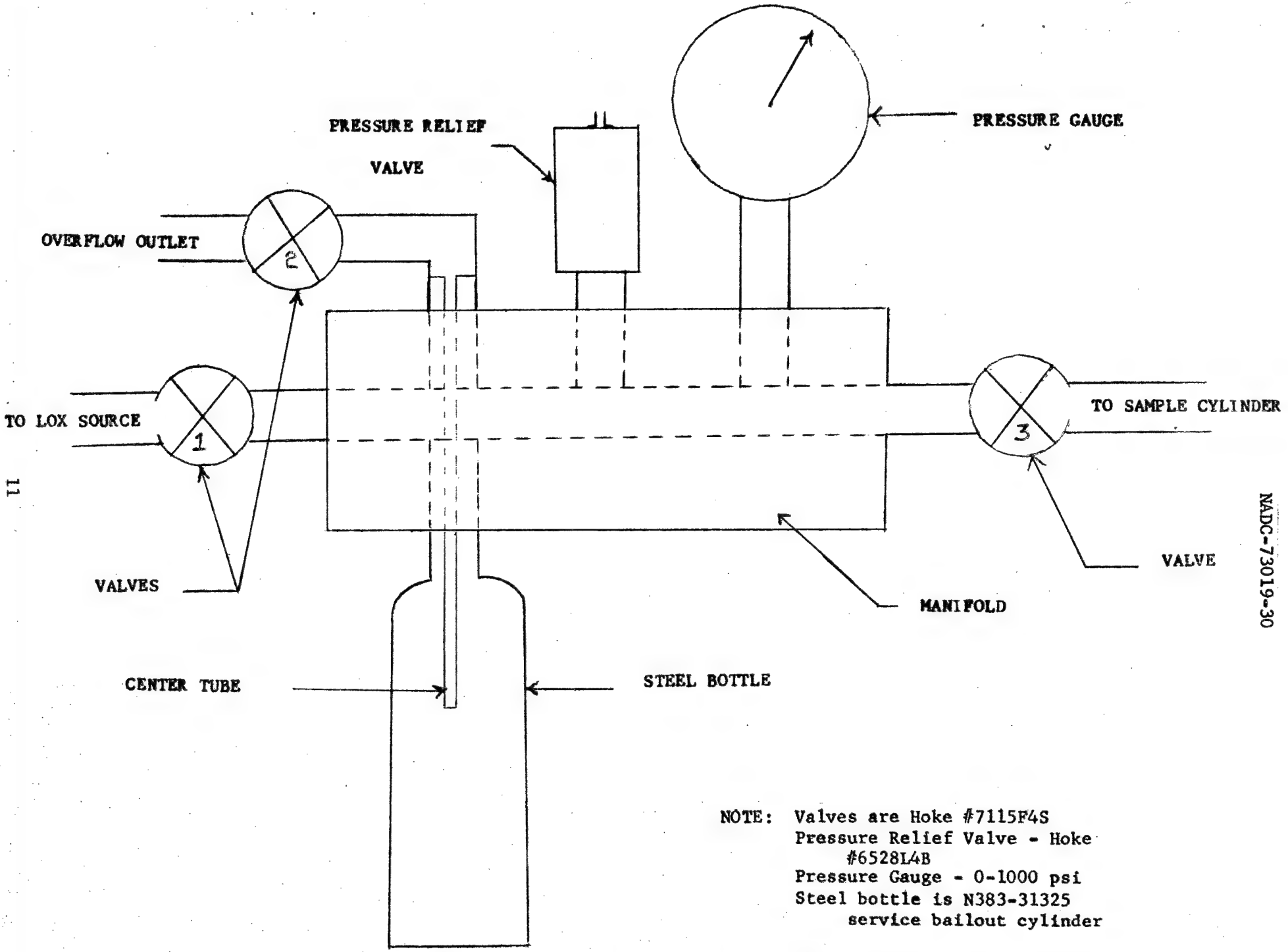


Figure 4. ASSEMBLY OF THE MODIFIED SAMPLING SYSTEM



NOTE: Valves are Hoke #7115F4S
Pressure Relief Valve - Hoke #6528L4B
Pressure Gauge - 0-1000 psi
Steel bottle is N383-31325 service bailout cylinder

Figure 5. MODIFIED PATUXENT RIVER SAMPLER

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Figure 6. MODIFIED PATUXENT RIVER SAMPLER - COOLING STAGE

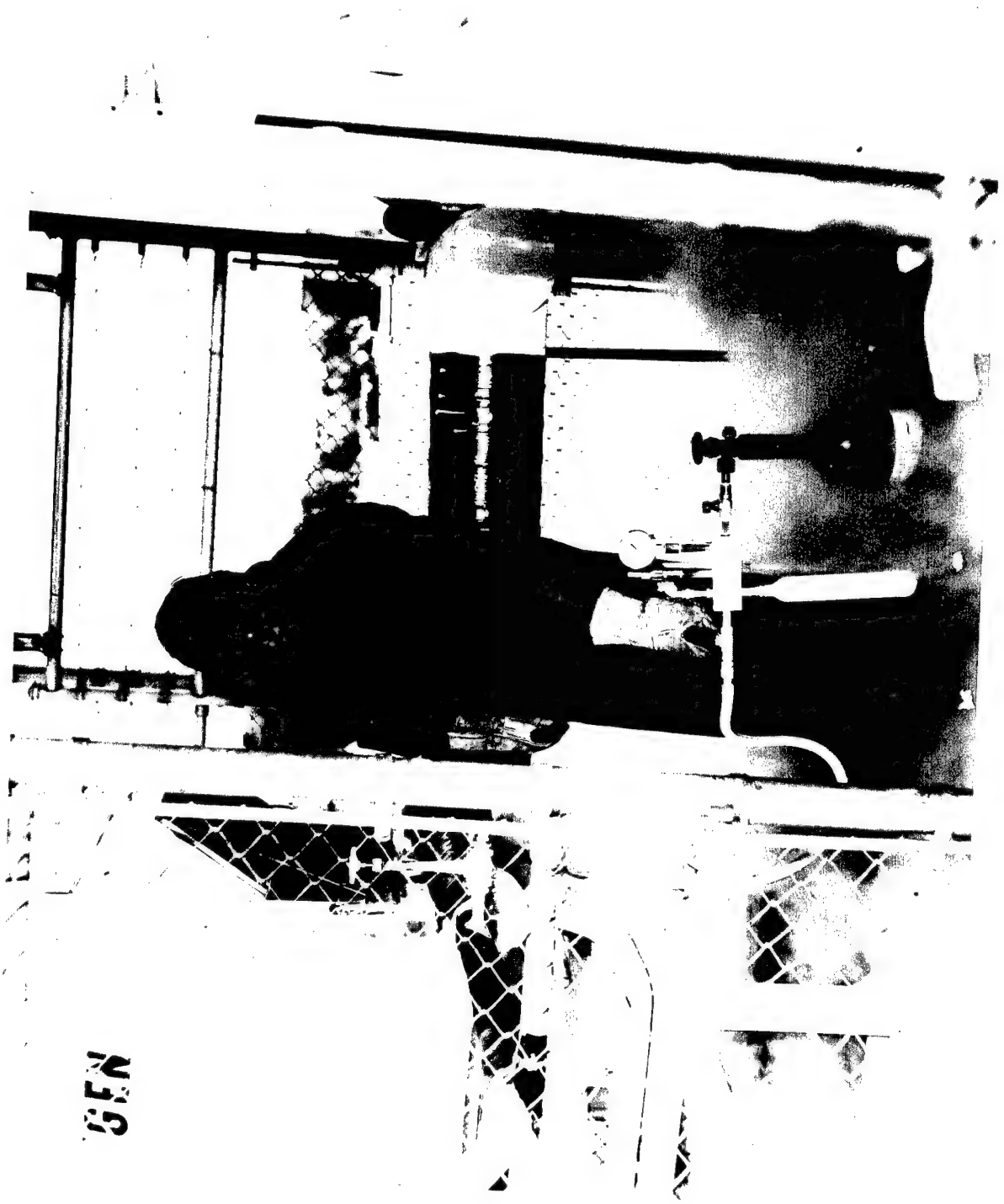

Figure 7. MODIFIED PATUXENT RIVER SAMPLER - SAMPLING STAGE

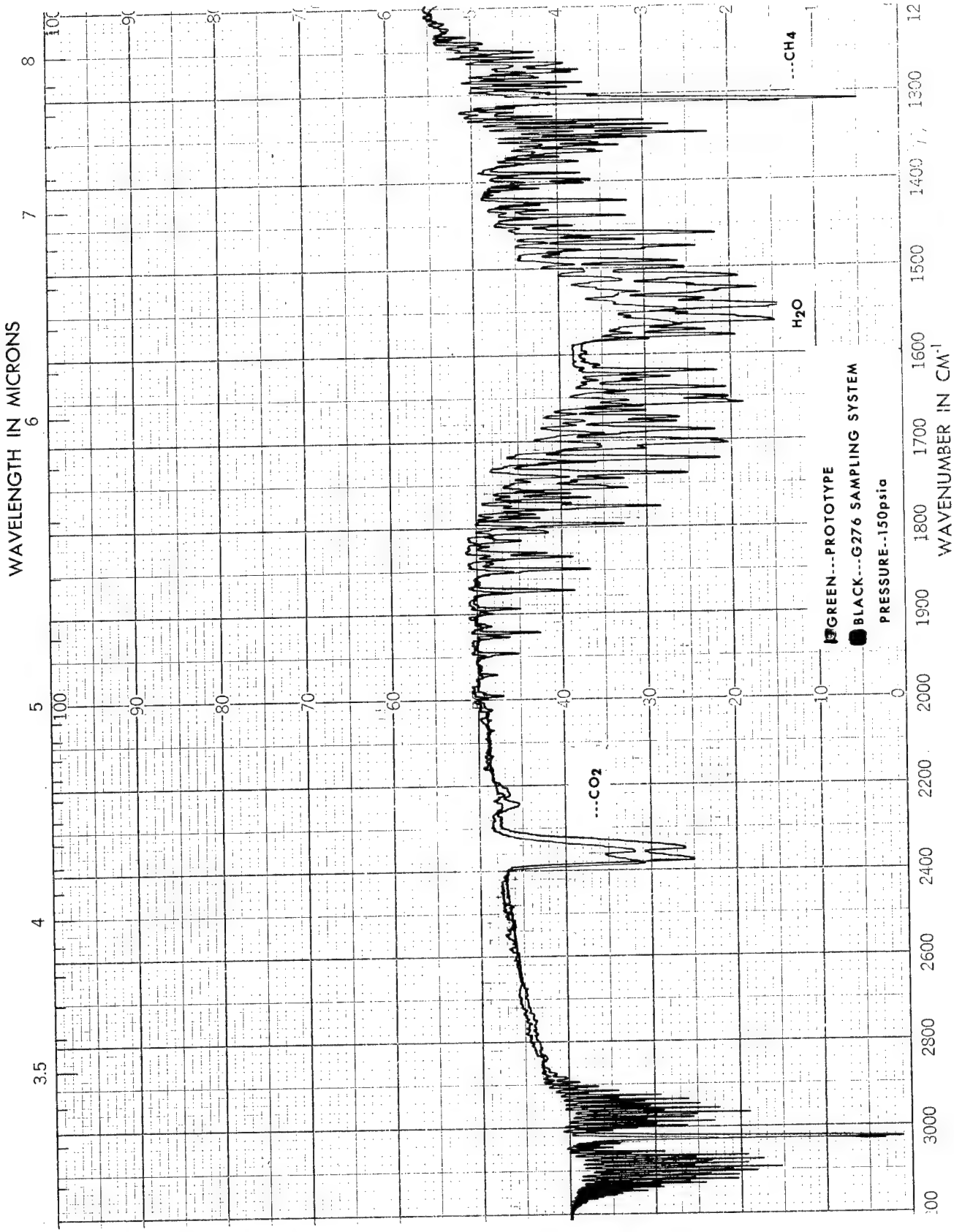
WAVELENGTH IN MICRONS
WAVENUMBER IN CM-1
---CO2
H2O
---CH4
GREEN---PROTOTYPE
BLACK---G276 SAMPLING SYSTEM
PRESSURE--150psia

Figure 8.

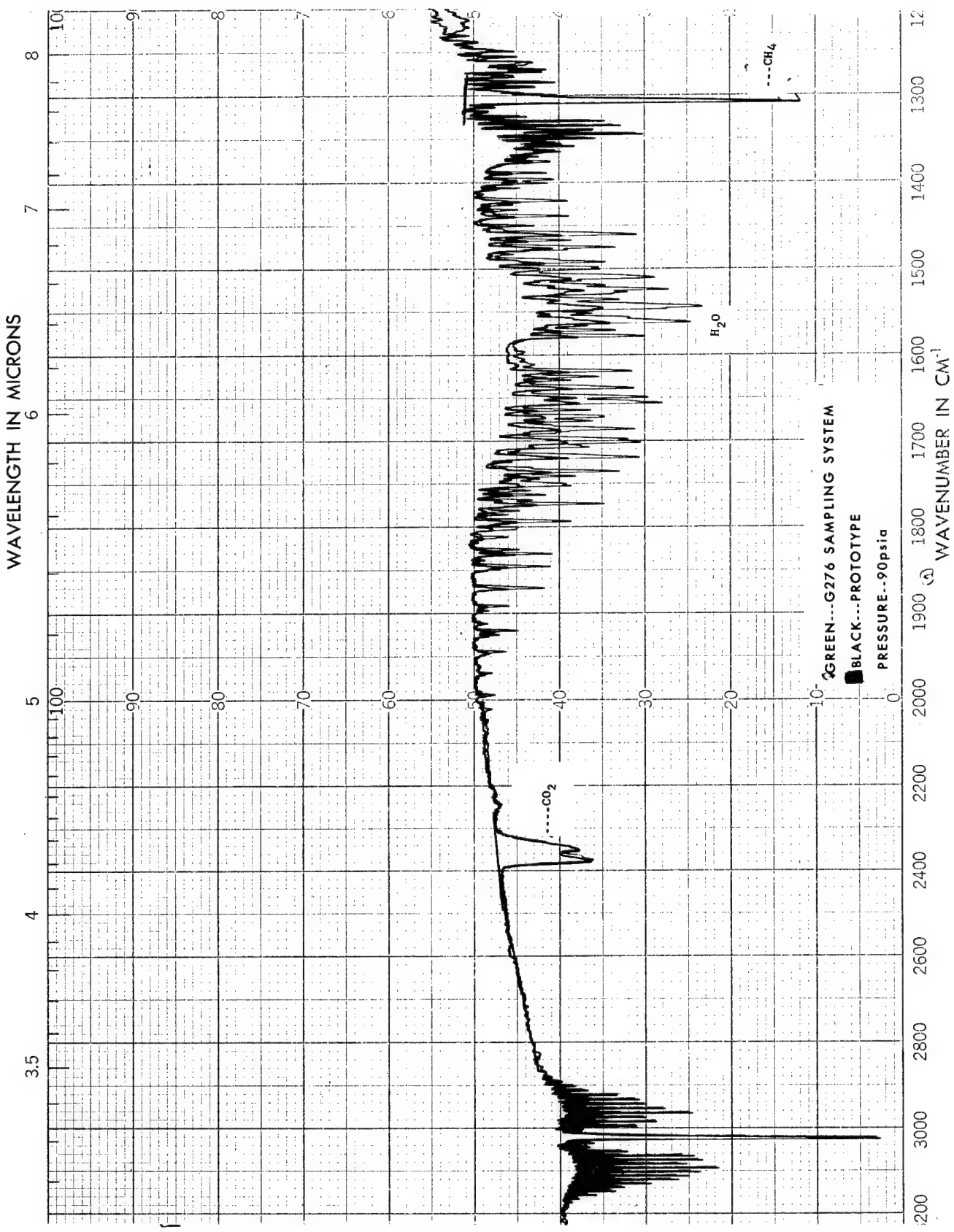
WAVELENGTH IN MICRONS
WAVENUMBER IN CM-1
GREEN---G276 SAMPLING SYSTEM
BLACK---PROTOTYPE
PRESSURE--90psia
CO2
H2O
CH4

Figure 9.

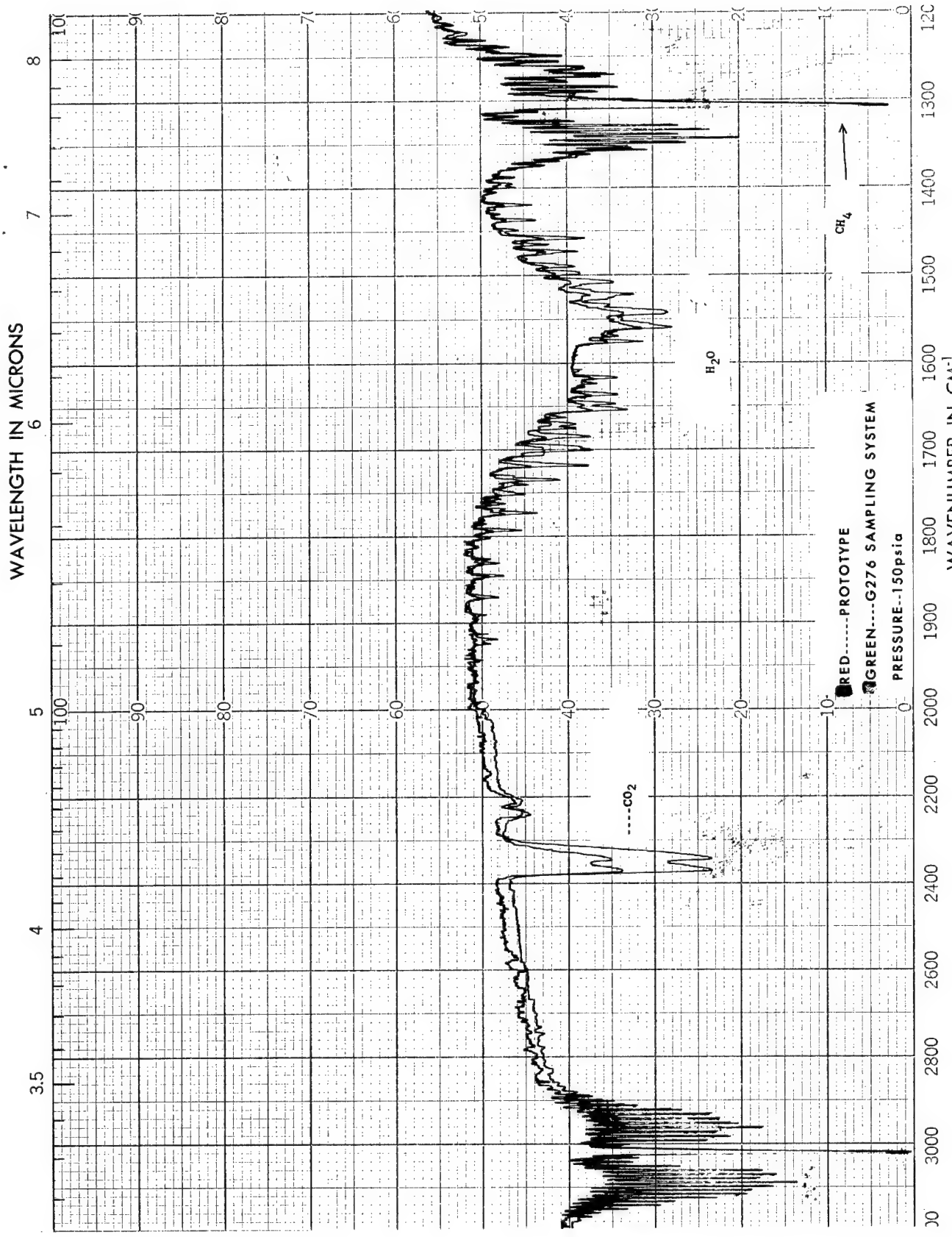
WAVELENGTH IN MICRONS
WAVENUMBER IN CM-1
CO_2
H_2O
CH_4
RED-----PROTOTYPE
GREEN----G276 SAMPLING SYSTEM
PRESSURE--150psia

Figure 10.

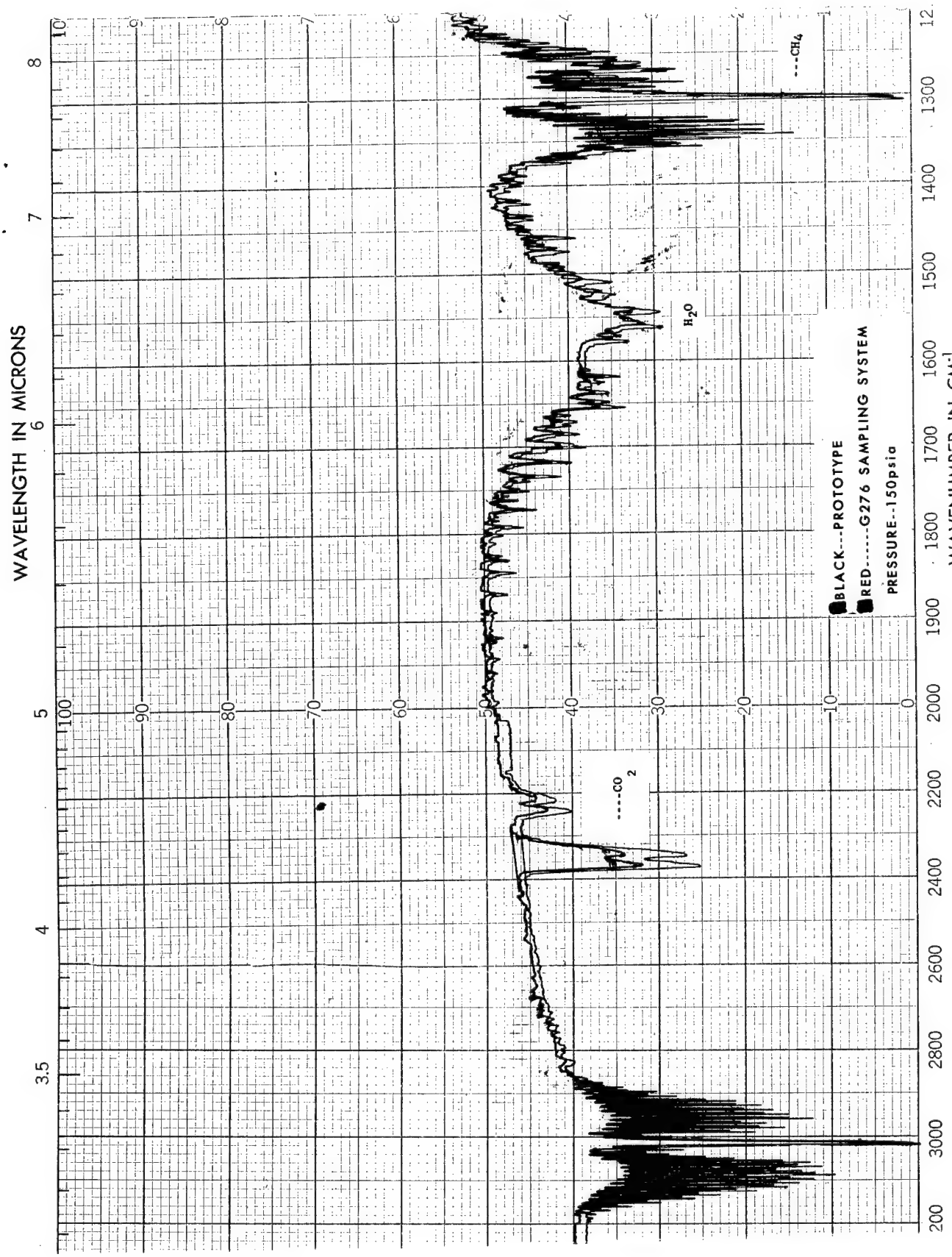
WAVELENGTH IN MICRONS
WAVENUMBER IN CM-1
---CH4
H2O
----CO2
BLACK---PROTOTYPE
RED-----G276 SAMPLING SYSTEM
PRESSURE--150psia

Figure 11.

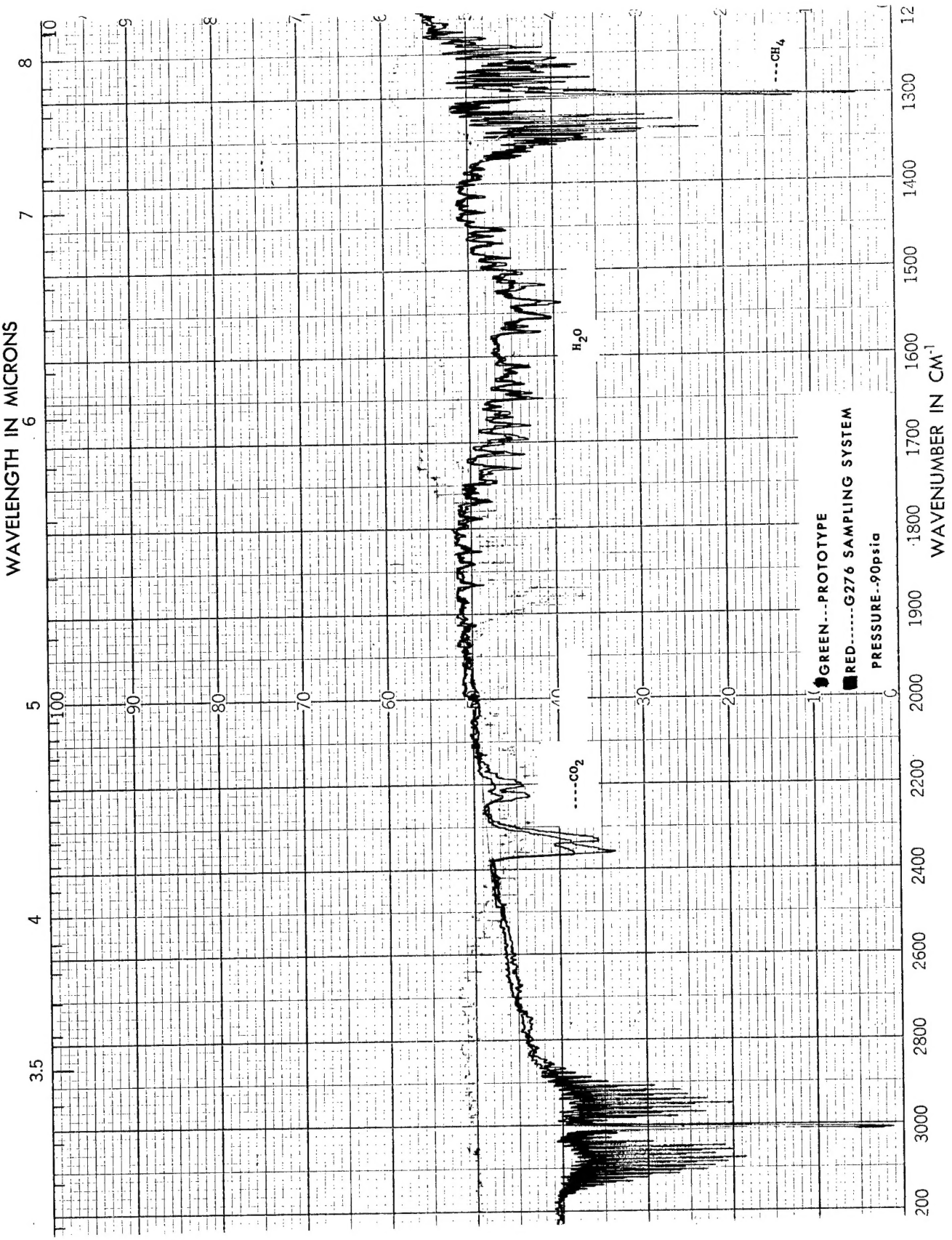
WAVELENGTH IN MICRONS
WAVENUMBER IN CM-1
CO_2
H_2O
CH_4
GREEN---PROTOTYPE
RED------G276 SAMPLING SYSTEM
PRESSURE--90psia

Figure 12.

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13. ABSTRACT

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